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British Standards Institution
Report

No. 13—1910.

British Engineering Standards Association.

(Incorporated 1918.)

Formed in 1901 as The Engineering Standards Committee

by

The Institution of Civil Engineers.
The Institution of Mechanical Engineers.
The Institution of Naval Architects.
The Iron and Steel Institute.
The Institution of Electrical Engineers.

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BRITISH STANDARD SPECIFICATION FOR STRUCTURAL STEEL FOR SHIPBUILDING.

(REVISED SEPTEMBER, 1910.)

LONDON:
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No. 13—1910.

British Engineering Standards Association.

(Incorporated 1918.)

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE

BY

THE INSTITUTION OF CIVIL ENGINEERS.
THE INSTITUTION OF MECHANICAL ENGINEERS.
THE INSTITUTION OF NAVAL ARCHITECTS.
THE IRON AND STEEL INSTITUTE.
THE INSTITUTION OF ELECTRICAL ENGINEERS.

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---

† Succeeded the late SIR JOHN WOLFE BARRY, K.C.B., February, 1918.

BRITISH ENGINEERING STANDARDS ASSOCIATION.

The following is a list of Members of the Sectional Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery, which was entrusted with the revision of the following Specification.

SECTIONAL COMMITTEE ON SECTIONS AND TESTS FOR MATERIALS USED IN THE CONSTRUCTION OF SHIPS AND THEIR MACHINERY.

September, 1910.

Chairman, MR. ARCHIBALD DENNY.

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Institution of Naval Architects, †Mr. James Dunn; Mr. W. J. Pratten.

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Institution of Engineers and Shipbuilders in Scotland, Mr. Alex. M. Kennedy; Mr. Alexander Gracie, M.V.O.

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Steel Ingot Makers' Association, †Mr. David Colville; Mr. Maxmilian Mannaberg.

English and Scottish Forge Masters' Association, Mr. A. D. Wedgwood.

Steel Forging Makers' Association
English and Scottish Steel Founders' Association } Mr. Bernard A. Firth.

Lloyd's Register of British and Foreign Shipping, †Mr. Samuel J. P. Thearle; Mr. J. T. Milton.

British Corporation for the Survey and Registry of Shipping, Mr. J. Foster King.

Bureau Veritas, Mr. John Gravell.

South Staffordshire Ironmasters' Association, Sir George Hingley, Bart.

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---

† Since deceased.

PREFACE TO FIRST EDITION.

The Committee on Ships Sections was appointed by the Main Committee on July 19th, 1901.

Having, in conjunction with the Committee on Bridges, and the Committee on Railway Rolling Stock Underframes, completed the Standard Lists of Rolled Sections for Structural Purposes, the Committee next dealt with Standard Specifications for Steel and Iron Material used in Shipbuilding. For this purpose the Committee was considerably enlarged and, under the title of the Sub-Committee on Tests for Steel and Iron Material used in the Construction of Ships and their Machinery, has held nine meetings. The Specification for Structural Steel for Shipbuilding was approved at a meeting on October 20th, 1903, and, at the request of the Sub-Committee, was referred by the Main Committee at their meeting on October 23rd, 1903, to the Committee on Bridges, and the Committee on Railway Rolling Stock Underframes.

It was further considered by the Sub-Committee on Tests for Steel and Iron Material used in the Construction of Ships and their Machinery at a meeting held on November 18th, 1904, and finally adopted.

This Report was approved by the Main Committee at their meeting held on December 8th, 1904.

A. DENNY,

Chairman of the Sectional Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery.

PREFACE TO SECOND REVISION. (1)

In consequence of representations having been made to the Committee with regard to the failure of Plates under cold flanging, the maximum tensile strength for Plates intended for this purpose has been reduced from 32 tons per square inch to 30 tons per square inch, but no alteration has been made to the lower limit of tensile strength nor to the elongation, which remain the same as before. In view of the importance of the alteration, it has been decided to make a fresh issue of the Specification, and the opportunity has been taken to provide in Clause 4 for the use of the 4 diameter test piece (Standard Test Piece **F**) when bars above 1 inch diameter are tested full size as rolled, or have been turned down, and the resulting test piece is above 1 inch diameter.

---

(1) The first revision was issued in September, 1906.

The Specification in its present form was approved by the Sectional Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery at their meeting held on June 29th, 1910.

The Report in its present form was approved by the Main Committee at their meeting held on July 22nd, 1910.

A. DENNY,

Chairman of the Sectional Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery.

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
STRUCTURAL STEEL FOR SHIPBUILDING.

(REVISED SEPTEMBER, 1910.)

Process of Manufacture.

1. Structural steel for Shipbuilding shall be made by the Open Hearth process, acid or basic, as may be specified, and as approved by the Inspecting body.

Freedom from Defects.

2. The finished material shall be free from cracks, surface flaws, and lamination. It shall also have a workmanlike finish, and must not have been hammer-dressed, but this does not prevent removal of slight scale or shell by the use of chisel, file, or buff.

Testing and Inspection.

3. The following tests and inspections shall be made at the place of manufacture prior to despatch; but, in the event of any of the material proving unsatisfactory in the course of being worked into vessels, such material shall be rejected, notwithstanding any previous certificate of satisfactory testing, and such further tests of the material from the same charge may be made as the Inspector in attendance may consider desirable.

Tensile Test Pieces.

4. The tensile strength and ductility shall be determined from Standard test pieces cut lengthwise or crosswise from the rolled material. When material is annealed or otherwise treated before despatch, the test pieces shall be similarly and simultaneously treated with the material before testing.

Plates:—Wherever practicable the rolled surfaces shall be retained on two opposite sides of the test piece. The elongation shall be measured on a Standard test piece having a gauge length of 8 inches.

For material more than 0·875 in. in thickness the width of the test piece between the gauge points shall not exceed 1½ ins.; for material 0·875 in. to 0·375 in. in thickness, inclusive, the width shall not exceed 2 ins.; for material less than 0·375 in. in thickness the width shall not be more than 2½ ins. In other respects the test pieces shall conform generally to the Standard Test Piece **A** (*see* Appendix containing the forms of British Standard Tensile Test Pieces, page 16).

Round Bars:—Bars may be tested full size as rolled, or they may be turned down to a convenient size and if tested one inch in diameter or under the test piece shall have a gauge length of not less than 8 times the diameter. When enlarged ends are used the length of the parallel portion shall be not less than 9 times the reduced diameter (*see* Standard Test Piece **B**, page 17). The sectional area of the test piece shall be not less than ¼ square inch. Where bars are above 1 inch diameter, and are tested full size as rolled, or have been turned down and the resulting test piece is above 1 inch diameter, a gauge length of 4 times the diameter may be used if preferred by the Manufacturer, in which case an increased elongation will be required, as specified in Clause 6. When enlarged ends are used the length of the parallel portion shall be not less than 4½ times the reduced diameter (*see* Standard Test Piece **F**, page 18).

Any straightening of test pieces which may be required shall be done cold.

Mechanical Tests and Selection of Test Pieces.

5. Plates and bars for ships' construction shall comply with the following mechanical tests. All test pieces shall be selected by the Inspector and tested in his presence, and he shall satisfy himself that the conditions herein described are fulfilled.

Tensile Tests.

6. Plates:—The tensile breaking strength of steel plates, determined from Standard test pieces, shall be between the limits of 28 and 32 tons per square inch. For plates specially intended for cold flanging and marked for identification the tensile breaking strength shall be between the limits of 26 and 30 tons per square inch. In the case of material for purposes in which tensile strength is not important, the tensile test may be dispensed with, and the bend test only made, if so specified and approved. The elongation, measured on a Standard test piece having a gauge length of 8 ins., shall be not less than 20 per cent. for material of 0·375 in. in thickness and upwards, and not less than 16 per cent. for material below 0·375 in. in thickness.

Angles, Bulb Angles, Channels, etc. :—The tensile breaking strength of sectional material, such as angles, bulb angles, channels, etc., shall be between the limits of 28 and 33 tons per square inch. The elongation measured on a Standard test piece having a gauge length of 8 ins. shall be not less than 20 per cent. for material of 0·375 in. in thickness and upwards, and not less than 16 per cent. for material below 0·375 in. in thickness.

Rivet Bars :—The tensile breaking strength of rivet bars shall be between the limits of 25 and 30 tons per square inch of section, with an elongation of not less than 25 per cent. measured on the Standard Test Piece **B** or 30 per cent. measured on Standard Test Piece **F** (*see* Appendix containing the forms of British Standard Tensile Test Pieces, pages 17 and 18). The bars may be tested the full size as rolled.

Number of Tensile Tests.

7. Plates and Sectional Material :—One tensile test for plates or sectional material shall be taken from the finished material of each charge.

When the quantity of the material from one charge at the thickness tested exceeds 25 tons, a second tensile test will be required ; also additional tests shall be made for every variation in thickness of 0·15 of an inch in the plates or sectional bars from each charge.

Rivet Bars :—At least one tensile test shall be taken from each charge used for rivet bars ; but when the weight of the bars, as rolled, from one charge exceeds 10 tons, an additional tensile test shall be made for each further 10 tons or portion thereof.

Should a tensile test piece break outside the middle half of its gauge length, the test may, at the Maker's option, be discarded and another test be made of the same plate or bar.

Bend Tests.

8. Cold Bends :—Test pieces shall be sheared lengthwise or crosswise from plates or bars, and shall be not less than 1½ ins. wide, but for small bars the whole section may be used. For rivet bars bend tests are not required.

Temper Bends :—The test pieces shall be similar to those used for cold bend tests. For temper bend tests the samples shall be heated to a blood red and quenched in water at a temperature not exceeding 80 degrees Fahr. The colour shall be judged indoors in the shade.

In all cold bend tests, and in temper bend tests on samples 0·5 in. in thickness and above, the rough edge or arris caused by shearing may be removed by filing or grinding, and samples 1 in. in thickness and above may have the edges machined, but the test pieces shall receive no other preparation. The test pieces shall not be annealed unless the material from which they are cut is similarly annealed, in which case the test pieces shall be similarly and simultaneously treated with the material before testing.

For both cold and temper bends the test piece shall withstand, without fracture, being doubled over until the internal radius is equal to 1½ times the thickness of the test piece, and the sides are parallel.

For small sectional material these bend tests may be made from the flattened bar.

Bend tests may be made either by pressure or by blows.

Number of Bend Tests.

9. A cold or temper bend test shall be made from each plate or bar as rolled, and these tests shall be in about equal numbers from each charge; but a cold bend test shall be made from all plates which are specially marked for cold flanging.

Tests for Manufactured Rivets.

10. Rivets selected by the Inspector from the bulk, in such proportion as may be specified and approved, shall withstand the following tests:—

(*a*) The rivet shanks to be bent cold, and hammered until the two parts of the shank touch in the manner shown in Fig. 1, without fracture on the outside of the bend.

(*b*) The rivet heads to be flattened, while hot, in the manner shown in Fig. 2, without cracking at the edges. The head to be flattened until its diameter is 2½ times the diameter of the shank.

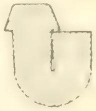


Fig. 1.

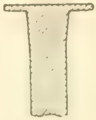


Fig. 2.

Additional Tests before Rejection.

11. Should the test pieces first selected by the Inspector not fulfil the test requirements, two further tests may be made, but should either of these fail, the plates or bars from which the test pieces were cut shall be rejected. In all such cases further tests shall be made before any material from the same charge can be accepted.

Branding.

12. Every plate and bar manufactured to this Specification shall be clearly and distinctly marked by the Maker in two places with an approved quality brand indicating that the material has complied with the Standard tests.

No plates or bars bearing this brand shall be forwarded from the Steel Works until the prescribed tests have been made by the Inspector, and the mill sheets signed by him. All plates and bars shall also be legibly marked in two places with the maker's name or trade mark, the place where made, and with number or identification marks by which they can be traced to the charge from which the material was made.

Maker's Certificate.

13. Before the mill sheets are signed, the Maker shall furnish the Inspector with a certificate guaranteeing that the material has been made by the Open Hearth process, as specified and approved, and that it has been subjected to, and withstood satisfactorily, the tests above described in the presence of the Inspector. The following form of certificate will be accepted if printed on each mill sheet with the name of the firm, and initialled by the Test House Manager:—

> "We hereby certify that the material described below has been made by the Open Hearth process, as specified and approved, and is that which has been satisfactorily tested in the presence of your Inspector in accordance with the Standard tests."

Rejected Material.

14. In the event of the material failing, in any case, to withstand the prescribed tests, the Inspector shall see that the quality brand stamped on the plates and bars by the Maker has been defaced by punch marks extending beyond the brand in the form of a cross, denoting that the material has been rejected.

Facilities for Inspection.

15. The Maker shall adopt a system of marking the ingots, billets, slabs, plates, bars, etc., which will enable all finished material to be traced to the original charge, and the Inspector must be given every facility for tracing all plates and bars to their respective charges, and for witnessing the required tests. When he is satisfied with the material and with the results of the tests, he shall be furnished with two copies of the advice notes of the material for his signature.

Steel not produced where Rolled.

16. Where steel is not produced in the works at which it is rolled, a certificate shall be supplied to the Inspector deputed to witness the testing of the material, stating the Open Hearth process by which it was made, the name of the Steel Maker who supplied it, also the numbers of the charges, for reference to the books of the Steel Maker. The number of the charge shall be marked on each plate or bar for the purpose of identification.

Occasional Attendance at Steel Works.

17. When the Inspector is not in regular attendance at the Steel Works, the Makers themselves may, with the written authority of the Inspecting body, comply with all the foregoing requirements, and shall furnish the Inspector with a certificate to the effect that the rules as to the testing of steel have been complied with in the case of the material submitted for approval. The Inspector shall then make check tensile, cold, and temper bend tests from not less than one plate or bar in every batch of 50 or less number, provided the batch be all from one charge. If more than one charge is represented, each charge shall be tested. Additional tests shall also be made for every variation in thickness of 0·15 of an inch. The test pieces shall be selected by the Inspector from the plates or bars, and not from shearings previously detached from them, and when marked by the Inspector for testing they shall be followed through the different stages of preparation until the tests are completed.

Should the tests be unsatisfactory, the whole of the material from the charge shall be rejected, and the Inspector shall see that the quality brand is satisfactorily defaced.

APPENDIX.

FORMS

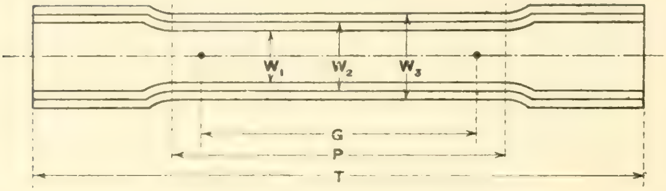
OF

BRITISH STANDARD TENSILE TEST PIECES.

APPENDIX.

FORMS OF BRITISH STANDARD TENSILE TEST PIECES.

TEST PIECE **A.**

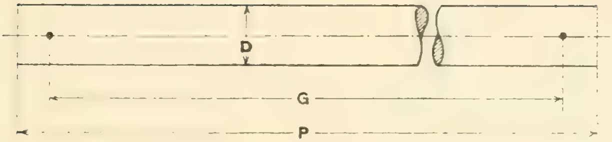


Gauge Length **G** = 8 inches.
Parallel Length **P** to be not less than 9 inches.
Total Length **T** = About 18 inches.

Thickness of Test Piece.	Maximum Width allowed.
Over $\frac{7}{8}$ in. (0·875 in.)	**W_1** = $1\frac{1}{2}$ ins.
$\frac{3}{8}$ in. (0·375 in.) to $\frac{7}{8}$ in. (0·875 in.)	**W_2** = 2 ins.
Under $\frac{3}{8}$ in. (0·375 in.)	**W_3** = $2\frac{1}{2}$ ins.

The widths of the test pieces for plates were selected to comply with the two following conditions. (1) As the great bulk of plates to be tested are from $\frac{3}{8}$ inch to $\frac{7}{8}$ inch thick, it was desirable for the sake of convenience that the test pieces for such plates should be of uniform width, and, in accordance with very general practice, a width of 2 inches was selected. (2) With a test piece of a given form, the percentage of elongation was found to be less for thick plates than for thin ones; with steel of the same quality in other respects it was desirable therefore to choose widths of test piece which would be slightly in favour of the thicker plates. This is secured with the widths selected for the Standard test piece of form **A.**

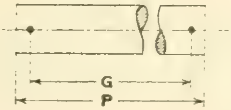
TEST PIECE **B.**



Gauge Length **G** to be not less than 8 times the diameter **D.**
With enlarged ends :—Parallel Length **P** to be not less
than 9 times the reduced diameter **D.**

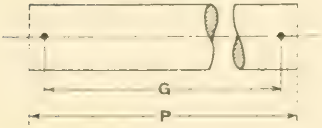
All test pieces of form **B** are strictly similar, and for the same material give the same percentage of elongation. They are nearly similar to a test piece of form **A,** 8 inches in gauge length, 2 inches wide and ⅜ inch thick.

TEST PIECE **C.**



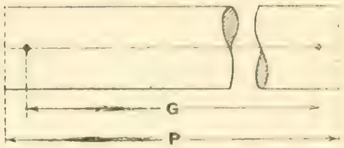
Gauge Length **G** = 2 inches.
Parallel Length **P** to be not less than 2¼ inches.
Dia. = 0·564 inch.
Area = ¼ sq. inch.

TEST PIECE **D.**



Gauge Length **G** = 3 inches.
Parallel Length **P** to be not less than 3⅜ inches.
Dia. = 0·798 inch.
Area = ½ sq. inch.

TEST PIECE **E.**

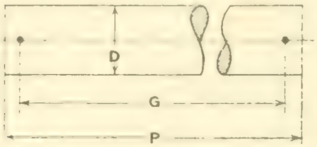


Gauge Length **G** = 3½ inches.
Parallel Length **P** to be not less than 4 inches.
Dia. = 0·977 inch.
Area = ¾ sq. inch.

Test Pieces **C, D,** and **E** were arranged to meet the very common practice of making test pieces for forgings, axles, tyres, etc., of either ¼ square inch or ½ square inch in sectional area. With the gauge lengths decided upon, these three forms are very nearly similar, and, for a given material, give very approximately the same percentage of elongation. Though not exactly, they are approximately similar to the Standard Test piece **F,** and for the same material give a nearly identical, but slightly greater, percentage of elongation.

TEST PIECE **F.**

(For Test Pieces over 1 inch diameter.)



Gauge Length **G** to be not less than 4 times the diameter **D.**
With enlarged ends :—Parallel Length **P** to be not less than 4½ times the reduced diameter **D.**

In some testing machines it was found inconvenient to use form **B** for bars of over 1 inch in diameter, and form **F** of half the gauge length is designed to meet such cases. For a given material the percentage of elongation with test piece **F** is greater than with test piece **B,** and this difference is provided for in the British Standard Specifications.

FORM OF ENDS.

In the case of the round test pieces **B, C, D, E** and **F,** the form of the ends is to be as required in order to suit the various methods employed for gripping the test piece. When enlarged ends are used the length of the parallel portion of the test piece must in no case be less than that noted on the diagrams.

British Engineering Standards Association.

PRICE LIST
OF
BRITISH STANDARD SPECIFICATIONS AND REPORTS.

NOVEMBER, 1919.

(This List cancels all previous Lists.)

NOTE.—*A number of the Publications of the Association are being issued in French, Italian, Spanish and Portuguese. The majority of the English Editions and all the Foreign Translations (which also include the English text) are being published in octavo form, and will be available at* 1/- *net per copy or its equivalent in Foreign moneys.*

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